Chapter 2
General Concepts

2-1. General

a. This chapter overviews the general concepts and components of flood warning - preparedness programs. Making a distinction between the various components of a flood warning - preparedness program is important. More detailed descriptions of flood warning - preparedness program components are included in the discussion of enhancements (Chapter 4).

b. The flood warning - preparedness program consists of the following components:

- *Flood-Threat Recognition*
- *Warning Dissemination*
- *Emergency Response*
- *Postflood Recovery*
- *Continued Plan Management*

Flood warning - preparedness plans vary significantly based on many factors, including: the hydrometeorological characteristics of the watershed, the population at risk, threatened properties, infrastructure, and the institutional capabilities and arrangements. The period between flood events is also important. Table 2-1 illustrates typical flood-threat recognition and emergency response components for different types of watersheds.

2-2. Flood-threat Recognition

Flood-threat recognition systems consist of activities and arrangements to enable early identification, location, and degree of potential flood situations. The primary elements of flood recognition systems are indicted below:

- *Monitoring*
  - *Measurement and detection*
  - *Data transmission*
  - *Data assembly and display*
- *Forecasting (additional to monitoring)*
  - *Data processing and analysis*
  - *Forecast preparation*
  - *Validation and updates*

The purpose of the flood-threat recognition system is to recognize the potential of a flood threat quickly, to continue to monitor the situation, and to predict or forecast the nature of the event. The goal is to determine the impact of the developing flood in the minimum time possible. The NWS has the overall responsibility for monitoring and forecasting flood situations for the nation. This information is primarily developed and disseminated for the major river basins of the country. Many communities have potential loss of life and property due to flooding of smaller and often flashy streams in developed areas. NWS precise forecasts are typically not available for these streams.

Table 2-1
Typical Flood Warning - Preparedness Plan Components

Watershed Type	Warning Time	Flood-Threat Recognition Component	Response Component
Small mountain streams (mountain streams, Hawaii coastal streams, small streams subject to cloud burst rainfall, etc.)	<6 hr	NWS precipitation forecasts, regional monitoring, observers.	Emergency evacuation of flood-plain.
Streams, tributaries, or small rivers (majority of watersheds with relatively mild slopes and drainage areas between 51.8 and 777 sq km (20 and 300 sq mi.))	6 to 24 hr	Stream gages and possibly rain gages. Monitoring and possible runoff forecasting model, depending on the capabilities of the local agencies. ALERT type systems.	Evacuation assistance, maintenance of vital services, relocation of property and other actions that can be accomplished within the warning time.
Large major river basins (Mississippi River, Sacramento River, Colorado River, etc.)	>24 hr	Raingage and stream gage monitoring, NWS forecasts. Corps water control real-time forecasting and regulation, sophisticated models.	All of the above in addition to significant flood-fighting effort.

a. Monitoring. The monitoring component of a flood-threat recognition system can vary from a simple staff gage that is observed and compared with a table or chart to an elaborate system consisting of a network of automated precipitation and/or stream gages. This is dependent on the size of the area, hydrometeorological characteristics, and the capabilities of the local community for operating and maintaining the system. Data measurement and detection, generally accomplished by instruments in the field, are important features of a monitoring system. The objective of the measurement and detection task is to monitor developing hydrometeorological conditions. This can include current watershed conditions and what might develop in the near term. Atmospheric parameters, measured rainfall, and current stream conditions can be observed. Another essential aspect of a monitoring system is data transmission, which is required to get the data to a central location for display and assessment.

b. Forecasting.

(1) Flood-threat recognition systems may or may not include flood forecasting. In any flood forecast system, using technology appropriate to the situation and the institution's capabilities to perform the forecasting function is important. Complex technologies employed in situations without local skills, resources, and long-term operational commitment may quickly lead to system failure. Conversely, it might not be appropriate to use solely monitoring where a forecast could provide time to reduce flood damage effectively. Appropriate technology considerations should be reviewed extensively during system design. Reliability, and thus redundancy, is important. These considerations should also be reviewed during the life of the system to account for evolving local capabilities and experience gained during flood events. The value of a forecast is derived from the additional time made available for the response effort to reduce damage. Figure 2-1 shows the flood warning - preparedness program continuum on a time scale relative to a flood event. It also shows how time saved by shortening the time needed to complete the flood-threat recognition system tasks contributes directly to the time available to carry out response actions.

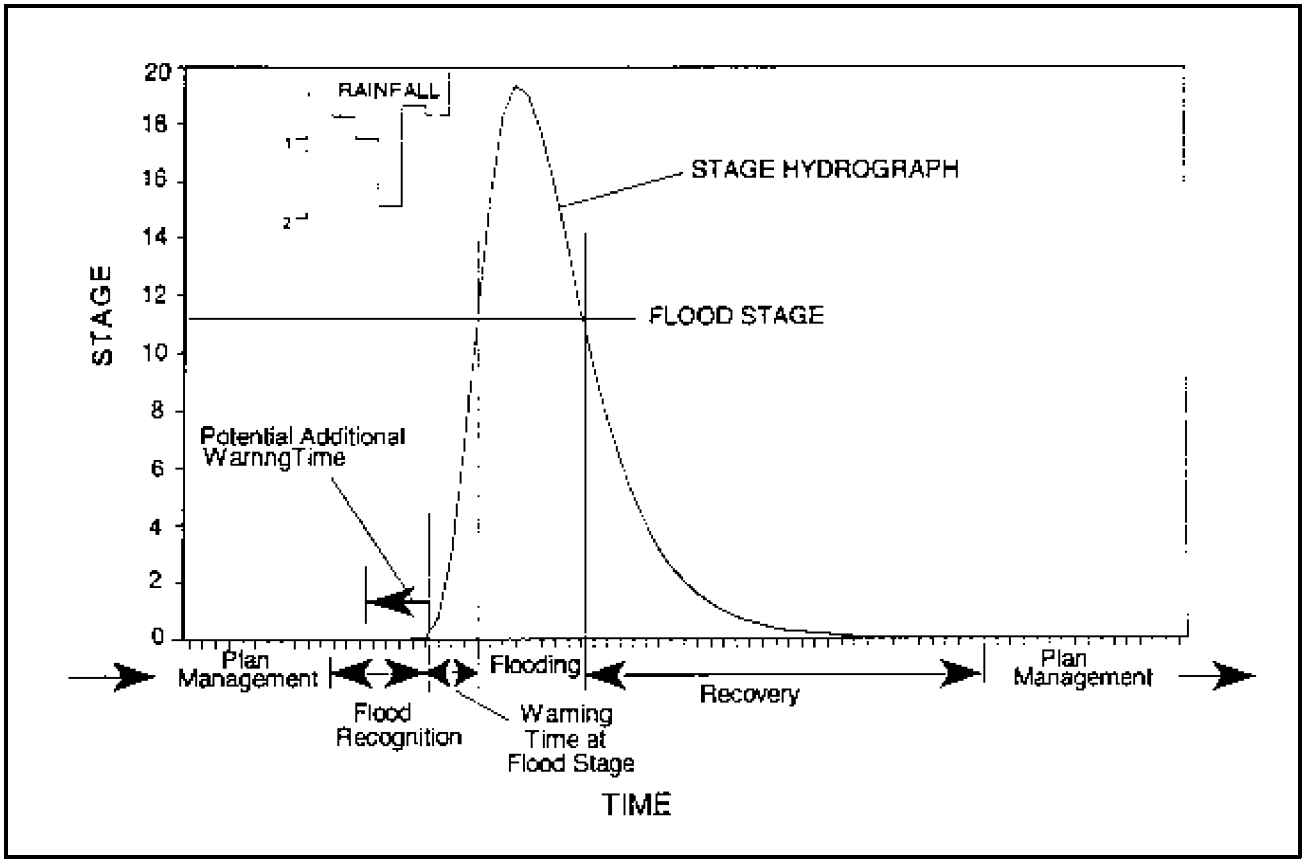

Figure 2-1. Flood warning - preparedness program time scale

(2) The value of a flood forecast is governed by two important attributes, accuracy and timeliness, which are mutually exclusive. Having the most accurate forecast *and* the most timely forecast is usually not possible. For example, it is possible to provide a very accurate forecast by checking the current stream levels and make a forecast 1/2 hr before flooding begins. However, the forecast would have little value since it is not timely enough to allow effective response actions to occur. On the other hand, it may be possible to make a forecast for a small stream indicating that a flood will occur tomorrow. However timely this forecast is, in all likelihood, it will not be very accurate.

(3) Automating much of the flood-threat recognition system reduces the time needed for certain activities, particularly, data transmission, data processing and analysis, and forecast preparation. The extra time can be used to increase time to respond *or* to get more information to provide a better forecast. It is often purely a judgment call of the forecaster which choice to make.

2-3. Warning Dissemination

Flood warning dissemination is a key element of any flood warning - preparedness program. Warning dissemination is the mechanism by which local officials and the effected public are informed that a flood threat condition exists. Methods of initially warning key personnel may include audio alarms, voice dial-out systems to "call" key officials, or beeper systems. Once emergency personnel have been activated, mass dissemination techniques come in to play. These techniques may include the use of public radio and television or special portable National Oceanic and Atmospheric Administration (NOAA) weather radios. Door-to-door warning dissemination can be used as well as sirens and public address systems. Procedures for evaluating warning dissemination techniques are included in Chapter 4.

2-4. Emergency Response

a. Preparedness planning identifies what must be done and who must do it. Emergency response actions are predetermined, documented, reviewed, and practiced in advance. The lead time available, accuracy, specificity, and the reliability of the forecast and warning system dictate the types of emergency response actions that take place. More lead time provides more opportunity to take damage-reducing actions. Higher accuracy, increased specificity, and better reliability mean floodplain residents can focus attention on the exact areas and elevations expected to flood, making response actions more efficient.

b. Advanced warning can be used in a variety of ways to respond to the impending flood (Owen 1980). Emergency response actions can include warning low-lying areas to evacuate, providing evacuation assistance, curtailing electric and gas service to prevent fire and explosions, establishing traffic controls, and dispersing fire and rescue services. If there is sufficient lead time, more aggressive activities can be accomplished to reduce property damage further such as moving public vehicles and equipment from low areas, relocating or stacking contents of private structures, or initiating flood-fighting efforts (e.g., sandbagging). Each action taken as the result of advanced planning and increased warning time has direct consequences in terms of derived benefits. The anticipated benefits from an enhanced flood warning - preparedness program can be categorized and associated with the contributing actions.

2-5. Continued Plan Management

The flood warning - preparedness program is a closed loop continuum of activities beginning and ending with plan management. Without a current and effective preparedness plan, any program is doomed to failure. Emergencies, particularly flash floods, leave little time to wonder how to respond. Preparedness planning identifies what needs to be done and who is to do it. The course of action is predetermined and documented, reviewed, and practiced in advance. Once a flood emergency begins, forecasts are made and floodplain occupants respond. As the emergency subsides, the recovery process begins. Emergency activities are reviewed and evaluated for continued plan management. The results of the evaluation may then lead to improvements to the preparedness plan. Closing the loop in this fashion is vitally important so that reactions and responses can improve based on the experience gained during an actual flood event.